EXPLORATORY TUNA FISHING IN THE CAROLINE ISLANDS

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Explanatory Note

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EXPLORATORY TUNA FISHING IN THE CAROLINE ISLANDS

Translated from the Japanese language by

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Pacific Oceanic Fishery Investigations

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1/ From South Sea Fishery News [Nanyō Suisan Jōhō] No. 4, Nov. 1937.

2/ From South Sea Fishery News [Nanyō Suisan Jōhō] No. 1 (1937), pp. 3-7.

3/ From Fisheries Experiment Station Progress Report No. 1, 1923-35. Published by the South Seas Government-General, Palau, December 1937.

4/ From South Sea Fishery News [Nanyō Suisan Jōhō] No. 3, October 1937, pp. 2-6.

Progress Report on Experimental Skipjack Fishing Near Yap

Scope of the Study

There is at present no fishery worthy of note, aside from that for trochus shell, within the jurisdiction of the Yap District of the South Seas Government-General, the only fishing being that carried on by the natives.

In 1934, when three fishing enterprises were operated there by three Okinawans, it was found that although bait was plentiful few skipjack schools came into the adjacent waters. The operations did not pay and the entrepreneurs transferred them to other islands. With such a background, a necessity was seen for a study of the skipjack fishery at Yap. Such a study was made by this station in 1936 and as a result it was recognized that the area does have value as a fishing ground, however, the firm establishment of the skipjack fishery there required further studies of the most detailed nature possible. Consequently the investigations were continued in the present fiscal year in order to clarify the total aspect of the waters around Yap.

Essentials of the Investigation

Research Vessels Zuihō Maru (183.54 gross tons, Mitsubishi Bikkādo 360 HP airless injection Diesel engine)
Hakuō Maru (10 gross tons, Niigata 25 HP semi-Diesel)

Area of Investigation Sea areas adjacent to Yap

Time of Investigation August 26 to September 25

Crews Zuihō Maru captain and 23 men Hakuō Maru 10 men
The technician in charge was aboard the Zuihō Maru from August 26 to September 7. His assistant was aboard from September 11 to 25.

Fishing Gear Used
Pole-fishing gear was employed.

Bait

The Hakuō Maru took bait with a stick-held dipnet using a hōmuraito [Home light?] (600 candlepower) and a Kimura type fishing light. Bait was taken at Yap Harbor and consisted mostly of tarekuchi [probably Engraulis heterolobus Rüppell] mixed with a small quantity of akaesa [probably apogonids or caesionids]. Two live fish pounds of a cube shape and measuring 12 feet on a side were used. Ordinarily two operations with the bait net were carried out within 4 or 5 hours after sunset and the catch was placed in these pounds. The contents of the two pounds were sufficient to fill one of the Zuihō Maru's bait-wells, amounting when measured in the water to 50 to 60 buckets. On moonlit nights little bait could be attracted and difficulty was experienced in taking bait.

Method of Investigation

Experimental fishing was carried out using pole-fishing gear. At the same time oceanographical observations were made on the fishing grounds, and studies were made of the distribution of the schools, the suitability of the fishing gear and methods, and the relationship between sea conditions and fishing conditions.

Outline of the Progress of the Experiments

The Zuihō Maru left Palau at 8:40 A.M. on August 26 towing the Hakuō Maru and headed for Yap. The next day at 5:30 P.M. the boats arrived at Yap, and the investigation was begun on the 28th. By September 5 four trials had been run. On September 6 they left Yap and arrived at Palau on the 7th to replenish provisions and drinking water and to land the catch. After taking on supplies they again headed for Yap at 5:00 P.M. on September 11, arriving at 1:30 P.M. on the 13th. The second phase of the investigation was begun on the 14th and by September 22 four trials had been made. The 23rd was devoted to preparations for winding up the investigation, and on the 24th the boats left Yap, returning to Palau on the 25th.

The results of this investigation were as follows:

Days operated 10 (including the operations of the Hakuō Maru)
Number of times schools were sighted 16
Number of times fished 11
Number of catches made 7
Number of times fish would not rise to bait 4
Number of fish taken
Skipjack 1,100
Tuna 151

BODY MEASUREMENTS

Station 1

	Body Length		Body Weight		Sex	Fatness*	
1	60.5	X	6.0	X		X	27.1
2	63.0		7.0				27.9
3	63.5		6.0				23.4

*["Fatness" or condition factor is found by the formula $10^3 \cdot W/L^3$.]

Station 3

	Body Length		Body Weight		Sex	Fatness	
1	67.0	X	7.5	X	+	X	24.9
2	64.0		6.0		+		22.8
3	64.0		6.5		+		24.7
4	63.0		6.0		-		23.9
5	64.0		6.5		-		24.8
6	63.0		6.0		-		23.9
7	62.0		6.0		+		25.2
8	62.0		6.0		+		25.2
9	61.0		5.5		-		24.2
10	65.0		6.5		-		23.7
11	62.0		6.0		+		25.2
12	59.0		5.5		+		26.8
13	63.0		6.0		+		23.9
14	63.0		6.5		+		26.0
15	62.0		6.0		-		25.2
16	61.0		5.0		+		22.0
17	61.5		6.0		-		25.8
18	61.5		6.0		+		25.8
19	60.5		5.0		+		22.6
20	60.5		6.0		-		27.1

Station 6

	Body Length		Body Weight		Sex	Fatness	
1	72.2	X	7.6	X		X	20.2
2	62.2		5.7				23.7
3	63.5		6.0				23.4
4	64.0		6.2				24.0
5	67.0		6.5				21.6
6	66.0		6.9				24.2
7	68.7		7.6				23.4
8	64.0		6.3				24.0
9	63.8		5.9				22.7
10	63.5		6.3				24.6
11	64.2		6.0		-		22.7
12	67.0		7.2		-		23.9
13	65.0		6.5		+		23.7
14	67.0		7.5		-		24.9
15	65.0		6.4		+		23.3
16	66.0		6.4		+		22.5
17	77.0		7.4		-		16.2
18	64.0		7.8		+		29.8
19	64.0		6.1		+		23.3
20	64.5		6.9		-		25.7

Station 7

	Body Length		Body Weight		Sex	Fatness	
1	71.2	X	7.6	X	-	X	21.1
2	65.3		6.2		+		22.3
3	63.0		5.8		-		23.2
4	62.2		5.1		-		21.2
5	62.0		5.6		-		23.5
6	62.8		5.9		+		23.8
7	60.5		5.4		+		24.4
8	63.0		5.1		+		24.4
9	63.7		6.2		+		24.0
10	62.5		5.7		-		23.3
11	63.5		5.9		+		23.0
12	64.0		6.1		+		23.3
13	63.0		5.4		-		21.6
14	65.3		6.7		+		24.1
15	64.0		6.2		+		23.7
16	60.0		5.5		+		25.5
17	61.7		5.3		-		22.6
18	60.5		5.3		-		23.9
19	64.4		6.4		-		24.0
20	63.2		5.9		+		23.4

Station 8

	Body Length		Body Weight		Sex	Fatness	
1	49.6	X	2.6	X	-	X	21.3
2	51.4		2.8		-		20.6
3	52.9		3.3		+		22.3
4	49.7		2.7		+		22.0
5	49.0		2.6		+		22.1
6	49.5		3.3		-		27.2
7	54.5		3.3		-		20.4
8	47.5		2.5		-		23.3
9	49.2		2.5		-		22.9
10	50.0		2.5		+		16.7
11	53.5		2.6		+		17.0
12	50.4		2.6		-		20.3
13	50.3		2.7		-		21.2
14	49.0		2.4		-		20.4
15	50.1		2.7		-		21.5
16	52.4		2.8		+		19.5
17	49.5		2.5		-		20.6
18	49.9		2.6		-		20.9
19	46.6		2.1		-		20.8
20	46.2		2.1		-		21.3

(note) + = male - = female

Fishing Situation

During the period covered by this investigation we fished a total of 10 days at various points around the island. We sighted schools 16 times, and fished 11 times. Catches were made in 7 of these trials, while in 4 cases the fish did not rise to the bait. Fish taken numbered 1,100 skipjack and 151 tuna. The main fishing grounds were west of NNW and SE [?], and catches were made from 2 to 15 miles offshore. Schools were rarely seen to the east and north and those which were found did not take the bait well. Schools were most plentiful near the shore reefs of the island, but these schools were made up of comparatively small skipjack. As we fished farther off shore the schools became less numerous, but the fish were larger and were in most cases mixed with tuna. About half of the skipjack taken had fairly well-developed ovaries.

Sea Conditions

Oceanographic observations were made on 8 different fishing grounds, water temperatures, specific gravities, and salinities being taken at the surface, 10, 25, 50, 100, and 200 meters. At the same time the water color and clarity were examined. The results are shown in the tables.

Water Color

Water color was determined by the use of Forel's standard fluid. The water in this area was almost all of No. 2 color, only that at Station 3 being of No. 1.

Water Temperature

Station \ Depth	Surface	10m	25	50	100	200
1	29.3	29.3	29.3	27.4	28.3	12.8
2	29.0	29.0	28.5	28.5	24.5	12.0
3	29.4	29.2	29.0	29.0	25.7	12.0
4	29.5	29.3	28.5	27.0	25.2	16.5
5	29.4	29.2	29.2	29.0	25.6	14.5
6	29.4	29.2	29.3	29.0	26.5	16.5
7	29.1	29.1	29.2	29.0	24.5	14.5
8	29.4	29.4	29.2	28.4	25.7	15.6

Maximum, minimum, and average temperatures at each level

Depth	Maximum	Minimum	Average	Range
Surface	29.5	29.0	29.31	
10m	29.4	29.0	29.21	.01
25	29.3	28.5	29.03	0.18
50	29.0	27.0	28.4	0.63
100	25.7	23.8	25.11	3.29
200	16.5	12.0	14.30	0.81

Specific Gravities

Station \ Depth	Surface	10m	25	50	100	200
1	25.25	25.32	25.32	25.67	25.83	25.49
2	25.21	25.21	25.21	25.56	25.89	25.59
3	25.15	25.16	25.22	25.32	25.77	25.52
4	24.79	24.86	24.86	24.86	25.40	25.25
5	24.75	24.86	24.91	25.03	25.44	25.26
6	25.10	25.10	25.29	25.44	25.49	25.40
7	25.03	25.13	25.18	25.26	25.62	25.53
8	25.04	25.13	25.22	25.32	25.58	25.54

Salinities

Station \ Depth	Surface	10m	25	50	100	200
1	34.04	34.13	34.13	34.58	34.79	34.34
2	33.98	33.98	33.98	34.45	34.87	34.49
3	33.91	33.93	34.00	34.13	34.72	34.38
4	33.44	33.53	33.53	33.53	33.23	34.04
5	33.39	33.53	33.58	33.75	34.29	34.05
6	33.84	33.84	34.09	34.29	34.34	34.23
7	33.75	33.87	33.95	34.05	34.52	34.40
8	33.77	33.87	34.00	34.13	34.47	34.42

Clarity

The clarity was measured by submerging a white plate 1 foot in diameter in the sea. Visibility showed an increase at stations east of Station 2, while it decreased to the west of that station. This may vary depending on the height of the sun, the strength of its rays, the presence and height of waves, and other factors, but it is considered to be roughly the situation described above.

Disposition of the Catch

The fish taken were held in the Zuihō Maru's cold storage, and were dry frozen. On our return to Palau they were canned by the Processing Department of this Station and some were made into dried fish-sticks by the Nankō Fishing Company. In both cases it was less than a week since the fish were taken and consequently they were good and fresh. The character of the flesh was the same as that of fish taken in Palau waters and showed no particular points of difference.

Results

This investigation extended over 10 days of operations, during the course of which schools were sighted 16 times, fishing was done 11 times, catches were made 7 times, and the fish failed to rise to the bait 4 times. The catch comprised 1,100 skipjack and 151 tuna. This could by no means be called successful fishing, but it does provide sufficient data to contradict the popular theory that "skipjack schools rarely come into Yap waters." Of course, the results of this experiment do not permit us to decide whether or not skipjack occur in this degree of abundance the year round in the waters of Yap, but considering the fact that last year's investigations (covering the period from June 14 to August 3) showed almost identical results, it appears that the skipjack grounds around this island do have a certain value. In particular the presence of an abundant supply of bait (mainly *tarekuchi* [probably *Engraulis heterolobus* Rüppell]) in Yap Bay is a strong point of this fishery, and it is worthy of note that the skipjack taken in the waters around this island are notably larger than those taken at Palau.

Experimental Skipjack Fishing
South Seas Government-General Zuihō Maru

		8-26	27	28	29	30
Date						
Symbol						
Latitude						
Longitude						
Vessels in sight						
Time of observation		noon	noon	noon	noon	noon
Weather, Amt. of clouds		C	C	B	B	B C
Wind direction, force		W 3	W 2	S 1	SE 1	N 3
Atmos. pressure		758.9	758.7	759.5	760.5	760.0
Atmos. temperature		29.5	29.0	30.0	29.0	28.0
Water temperature	0 m	29.0	29.0	29.0	29.0	29.5
	10 m					
	25 m					
	50 m					
	100 m					
	200 m					
Specific gravity	0 m					
	10 m					
	25 m					
	50 m					
	100 m					
	200 m					
Water color						
Transparency						
Direction of current						
Velocity of current						
Amt. of zooplankton						
Amt. of phytoplankton						
Type of school						
Size and density						
Biting						
Time gear used						
No. of hooks						
Bait species						
Number of bait fish						
Value of bait						
Large skipjack taken						
Medium skipjack taken						
Small skipjack taken						
*Maguro taken						
Big-eyed tuna taken						
Other catch						
Value catch						
Species of food						
Quantity of food						
Condition of gonads						
Notes		Left Palau harbor for Yap at 8:40 A.M. with Hakuō Maru in tow	Arrived Yap 5:30 P.M.	Making preparations for the survey; Hakuō Maru went to take bait.	Hakuō Maru taking bait.	Started out at 5:30 A.M.; headed for fishing grounds after taking on bait. Found no schools, returned at 6:15 P.M.

*/ Maguro is a general term for "tuna", and in this case probably means yellowfin. /

Experimental Skipjack Fishing
South Seas Government-General Zuihō Maru

Date		8-31	9-1	2	3
Symbol			1		2
Latitude			9°36'N		9°17'N
Longitude			138°03'E		138°06'E
Vessels in sight					
Time of observation		noon	11:00	noon	noon
Weather, Amt. of clouds		R	C 7	B	B C
Wind direction, force		SE 2	SE 1	SW 2	SW 1
Atmos. pressure		761.5	759.5	760.5	760.2
Atmos. temperature		29.5	27.0	20.0	30.0
Water temperature	0 m	30.0	29.3	30.0	29.0
	10 m		29.3		29.0
	25 m		29.3		28.5
	50 m		27.4		28.5
	100 m		23.8		24.5
	200 m		12.8		12.0
Specific gravity	0 m		25.25		25.21
	10 m		25.32		25.21
	25 m		25.32		25.21
	50 m		25.67		25.56
	100 m		25.83		25.89
	200 m		25.49		25.59
Water color			2		1
Transparency			31 m		42 m
Direction of current					
Velocity of current					
Amt. of zooplankton					
Amt. of phytoplankton					
Type of school					
Size and density					
Biting			no good		fairly good
Time gear used			9:40 -		14:35
No. of hooks			15		15
Bait species			tarekuchi*		tarekuchi
Number of bait fish					
Value of bait					
Large skipjack taken			3		174
Medium skipjack taken					
Small skipjack taken					
Maguro taken			1		
Big-eyed tuna taken					
Other catch					
Value catch					
Species of food					
Quantity of food					
Condition of gonads					
Notes		Engaged in shipboard repairs; Hakuo Maru taking bait.	Headed for fishing grounds at 6:20 P.M. Found schools but did not bite well. Returned at 4:30 PM with small catch.	Catching bait	Headed for fishing ground at 6:20 A.M. Sighted school 12:20, caught 24. At 2:00 P.M. again found school, took 150 fish. Returned at 4:25.

*probably Engraulis heterolobus Rüppell

Experimental Skipjack Fishing

South Seas Government-General Zuiho Maru

Date		9-4	9-5	6	7	11
Symbol			3			4
Latitude			9°16'5"N			9°31'N
Longitude			137°55.5'E			138°00'E
Vessels in sight						
Time of observation		noon	14:50	noon	noon	
Weather, Amt. of clouds		R	C 9	B	B C	C 7
Wind direction, force		NE 1	E 2		SW 2	W 1
Atmos. pressure		761.0	761.0	761.5	761.5	
Atmos. temperature		25.5	29.0	30.0	29.0	29.0
Water temperature	0 m	29.5	29.4	30.0	29.5	29.5
	10 m		29.2			29.3
	25 m		29.0			28.5
	50 m		29.0			27.0
	100 m		25.7			25.2
	200 m		12.0			16.5
Specific gravity	0 m		25.15			24.79
	10 m		25.16			24.86
	25 m		25.22			24.86
	50 m		25.32			24.86
	100 m		25.77			25.40
	200 m		25.52			25.25
Water color			2			2
Transparency			33 m			32 m
Direction of current						W
Velocity of current						1
Amt. of zooplankton						
Amt. of phytoplankton						
Type of school						birds
Size and density						thin
Biting						no good
Time gear used						
No. of hooks						
Bait species						tarekuchi
Number of bait fish						8 scoops
Value of bait						
Large skipjack taken						51
Medium skipjack taken						26
Small skipjack taken						
Maguro taken						18
Big-eyed tuna taken						
Other catch						
Value catch						
Species of food						
Quantity of food						
Condition of gonads						
Notes		Taking bait	Headed for fishing ground at 6:28 A.M. Sighted schools 3 times but they did not bite. Returned at 5:40 P.M.	Departed Yap for Palau at 9:00 A.M.	Arrived Palau 1:40 P.M.	Operation carried out aboard Hakuō Maru.

Experimental Skipjack Fishing
South Seas Government-General Zuihō Maru

Date		9-12	13	14	15	16
Symbol		5			6	
Latitude		9°40'N			9°31'N	
Longitude		138°08'E			138°01'E	
Vessels in sight						
Time of observation			noon	noon	12:10-12:35	noon
Weather, Amt. of clouds		BC 6	B	C	C 8	C
Wind direction, force		N 1	E 1	E 1	SSE 2	S 2
Atmos. pressure			760.8	759.5		759.5
Atmos. temperature		28.0	29.5	26.0	28.4	30.0
Water temperature	0 m	29.4			29.4	
	10 m	29.2			29.3	
	25 m	29.2			29.2	
	50 m	29.0			29.0	
	100 m	25.6			26.5	
	200 m	14.5			16.5	
Specific gravity	0 m	24.75			25.10	
	10 m	24.86			25.10	
	25 m	24.91			25.29	
	50 m	25.03			25.44	
	100 m	25.44			25.49	
	200 m	25.26			25.40	
Water color		2			2	
Transparency		44 m			33 m	
Direction of current		5				
Velocity of current		0.5				
Amt. of zooplankton						
Amt. of phytoplankton						
Type of school		birds			birds	
Size and density		dense			fairly dense	
Biting		good			fairly good	
Time gear used					11:35-12:07	
No. of hooks					13	
Bait species		tarekuchi			tarekuchi	
Number of bait fish		8 scoops			10 scoops	
Value of bait						
Large skipjack taken		124			161 ?	
Medium skipjack taken					[may be 61 or 161]	
Small skipjack taken						
Maguro taken						
Big-eyed tuna taken						
Other catch						
Value catch						
Species of food						
Quantity of food						
Condition of gonads						
Notes		Operation by Hakuō Maru	Arrived Yap at 12:20 P.M. This vessel [Zuihō] left Palau at 5:00 P.M. on the 11th.	Taking bait	Departed Yap at 5:00 A.M. Returned at 2:30 P.M.	Taking bait

Date		9-21	9-22
Symbol			8
Latitude			9°40'N
Longitude			138°8'45"E
Vessels in sight			
Time of observation		noon	10:00-10:19
Weather, Amt. of clouds		B	B 3
Wind direction, force		E 1	NE 1
Atmos. pressure		760.0	760.0
Atmos. temperature		28.0	29.0
Water temperature	0 m		29.4
	10 m		29.4
	25 m		29.2
	50 m		28.4
	100 m		25.7
	200 m		15.6
Specific gravity	0 m		25.04
	10 m		25.13
	25 m		25.22
	50 m		25.32
	100 m		25.58
	200 m		25.54
Water color			2
Transparency			43 m
Direction of current			
Velocity of current			
Amt. of zooplankton			
Amt. of phytoplankton			
Type of school			birds
Size and density			fairly dense
Biting			fairly good
Time gear used			10:00-11:20
No. of hooks			14
Bait species			tarekuchi
Number of bait fish			9 scoops
Value of bait			
Large skipjack taken			299
Medium skipjack taken			
Small skipjack taken			62
Maguro taken			
Big-eyed tuna taken			
Other catch			
Value catch			
Species of food			
Quantity of food			
Condition of gonads			
Notes		Starting at 3:00 A.M. tried unsuccessfully to take bait. Called off fishing and took night bait.	Left for fishing ground at 5:00 A.M. Saw several schools but they ran away after briefly rising to bait. Perhaps pursued by predators. Returned at 2:30 P.M.

[3 days' entried covering preparations for return and voyage to Palau have been omitted from the translation.]

Report of the Progress of Experimental Tuna Fishing Near Woleai

The skipjack and tuna fisheries, which are the backbone of the fishing industry of the South Seas, have made remarkable progress in recent years, but these developments have been limited to the Palau, Truk, Ponape, and Saipan areas, these fisheries having been almost entirely neglected in the so-called outlying islands. This is, of course, related to the question of processing the catch, however, when we consider the future of the fishing industry in the islands we cannot for a moment overlook the fisheries of these outlying areas. Consequently, in planning the overall promotion of the islands' fisheries we are anticipating the development of these outlying areas by gradually carrying out experimental skipjack and tuna fishing investigations in them. The present report is the result of an experimental tuna fishing investigation in the waters adjacent to Woleai.

The writer carried out this investigation aboard the Zuihō Maru during eighteen days, from April 8 to April 25. It was impossible to arrive at any definite conclusions in such a short period of time, however, the general outline of the progress of the investigation is reported here.

Main Points of the Investigation

Research vessel Zuihō Maru (183.54 gross tons, Mitsubishi Bikkādo 360 HP airless injection Diesel engine)
Area investigated Woleai to Lamotrek
Time of investigation April 8 - 25, 1936
Crew 1 technician in charge and 23 men
Gear employed 40 baskets of tuna longlines
Construction of one basket

Trunk-line	Nanking hemp, .3 inch diameter, 22-thread, 200 fathoms long (8 25-fathom pieces)
Branch lines	.24" diameter, 23-thread, 3 lines 15 fathoms long, 3 lines 7½ fathoms long
Float lines	Same material as branch lines, 2 lines 15 fathoms long
	Cotton-wrapped hemp 6 pieces 4 fathoms long
	Wire leader 6 pieces 1 fathom long
	Hooks 6 Tosa style, 4.2 inch

Bait used

Iwashi taken with a throw-net inside the reef at Palau were salted and used for bait.

Method of investigation

Experimental fishing with longlines was done and at the same time oceanographic observations were made on the fishing grounds. An effort was made to provide basic data for commercial operations by studying the distribution of schools, their migrations, the suitability of the fishing gear and methods, and the relationship between oceanographic and fishing conditions.

Outline of the progress of the investigation

The vessel left Palau for Woleai April 8. On the way 100 drift bottles were released at 7°- 23' N. 142°-24' E. in order to make a study of the ocean currents. Work was begun on the investigation on the 10th. The first test was run about 38 miles WSW of Woleai, and the next 7 sets were made 10 to 25 miles off Woleai. Three trials were made north of the Ifalik Is., and one each at Olimarao and Lamotrek. Altogether 13 tests were made and the investigation was concluded on April 25. (See the accompanying table for a summary of operations.)

The following is an outline of the results achieved on this voyage:

Days sailed	15	Days operated	13
Number of sets	13	Number of catches	8
Total baskets	508	Total hooks	3,048
Ratio of tuna catch (per 100 hooks)	0.33		

Fish caught by species

Yellowfin	4	Big-eyed	1	Spearfish	5
Skipjack	2	Sharks, etc.	12		

Fishing Situation

On the whole these trials showed a poor fishing situation with no remarkable catches. Out of 13 sets, tuna were taken 6 times. For a total of 3,048 hooks fished, only 4 yellowfin, 1 big-eye, and 5 spearfish were taken. The ratio of tuna taken per 100 hooks was only 0.33, a very poor figure.

Breaking these figures down by areas fished, the ratio for the area 38 miles WSW of Woleai (A) was the highest with 1.25, and the Ifalik (K) and Lamotrek (M) areas followed with 0.83 each. Almost no catches were made in the areas 10 to 20 miles off Woleai, but in these areas the highest catch ratios appeared farthest from shore, indicating perhaps that all of the fish of these species found in the waters adjacent to Woleai are migratory fish engaged in periodic migrations in search of food. (See the attached table of fishing operations.)

Considering the catch ratios for the various branch lines, which on the gear used were of 15 and 7½ fathoms length, no fish at all were taken on the short branches.

An examination of the catch by species shows a peculiar phenomenon in that spearfish were taken east of Ifalik while tuna were taken to the west of that island. The sharks were all caught in the area between Ifalik and Lamotrek, none being taken near Woleai.

The tuna schools, rare as they were, appeared to be distributed to the west of Ifalik, while the spearfish were distributed to the east.

The yellowfin were all from 66 to 83 pounds weight, while the spearfish were all about 99 pounds.

Oceanographic Conditions

Observations made at all stations of the water temperatures, specific gravities, and hydrogen ion concentrations at the surface, 25 meters, 100 meters, 200 meters, and 300 meters showed the following conditions:

(1) Temperatures

The distribution of sea water temperatures in the various areas during the period of this investigation was almost perfectly uniform, with very similar readings at each level. Surface temperatures were from 28.3 to 29.0 degrees, at the 25-meter depth from 28.5 to 29.0 degrees, at 50 meters 28.4 to 29.0 degrees, and at 100 meters 27.1 to 28.8 degrees.

The face that the surface temperatures were lower than those found at the 25-meter level appears to be the result of the effect of the air temperature on the surface level.

There is a sharp drop in temperature at the 200-meter level with a range of 12 to 13 degrees between the temperatures at 100 and 200 meters, that at the latter depth being ordinarily 14.2 to 16.7 degrees. The temperatures at 300 meters are even lower, being from 7.9 to 11.1 degrees.

The temperatures of 28.1 degrees at 200 meters and 27.5 degrees at 300 meters off southern Woleai (Station E) are thought to be due to the appearance of a localized high temperature belt in that area.

Maximum and Minimum Temperatures at Each Level

Depth	Maximum	Minimum	Average	Range
Surface	29.0	28.3	28.72	0.021
25 meters	29.0	28.5	28.76	0.08
50 meters	29.0	28.4	28.68	0.63
100 meters	28.8	27.1	28.05	11.64
200 meters	28.1	14.2	16.41	4.44
300 meters	27.5	7.9	11.97	

(2) Specific Gravities

Specific gravity was determined by titration with silver nitrate using potassium chromate as the indicator.

Just as in the case of the water temperatures, similar results were obtained in all of the areas. Only the area north of Ifalik showed a low specific gravity, while the figures for Woleai and Lamotrek were almost identical. Except for one or two stations the vertical distribution of densities showed lower specific gravities as the depth increased, a phenomenon which differs remarkably from that seen at Palau (where the

highest specific gravities are found at the 100- to 200-meter levels, lower readings being obtained both at greater and at lesser depths). (See the accompanying table of operations.)

Maximum, Minimum and Average Specific Gravities at Each Level

Depth	Maximum	Minimum	Average	Range
Surface	25.80	25.44	25.69	
25 meters	25.72	25.44	25.65	0.04
50 meters	25.70	25.50	25.64	0.01
100 meters	25.72	25.55	25.63	0.01
200 meters	25.64	25.44	25.58	0.05
300 meters	25.65	25.44	25.56	0.05

(3) Hydrogen Ion Concentration

At six stations near Woleai the hydrogen ion concentration varied from 8.3 to 8.5 for the surface and 25-meter levels, 8.4 at the 50- and 100-meter levels, and 8.1 to 8.4 at 200 and 300 meters. As for vertical distribution, four of the six stations showed decreasing concentrations at lower depths. Observations at one of the other two stations showed identical strata while at the other the strata were irregular.

This indicates that in the waters adjacent to Woleai the hydrogen ion concentration decreases as the depth increases. The variation as between the surface and the 100-meter level is comparatively slight, but at greater depths a marked lowering of basicity is seen. (See the accompanying table of operations.)

(4) Water Color and Clarity

Water color was determined by the use of Forel's standard fluid. The results of 14 observations showed that in the area between Woleai and Lamotrek the water color is generally No. 2 or No. 3 on the Forel scale. No. 3 predominated, No. 2 being observed at only two stations, both near Ifalik (Stations J and K). That is to say, in the area between Woleai and Lamotrek the water color in the areas east and west of the waters surrounding Ifalik Is. was No. 3.

A white disk 33 centimeters in diameter was employed to measure the clarity of the sea water. The disk was sunk in the water and the depths at which it could be seen were measured. Combined results of 11 observations give a maximum visibility of 35 meters and a minimum of 27 meters, the average being 31 meters. In general it is worthy of note that the visibility was greater west of Woleai than it was to the east of that island.

(5) Currents

Direction and rate of currents were estimated by observation. Results of observations at 15 stations show that in the Woleai-Ifalik area both northerly and southerly currents turn westward and mingle, presenting a complex situation. In the Lamotrek-Olimarao area the current appears to set southwest and no trace of an easterly current is seen. Velocities of currents were from ½ to 1 knot.

On the Handling of the Catch

The fish were all gutted after they were taken and were placed in the ship's refrigerator. They were than prepared for storage by means of a freezer ((American-made Frick ammonia direct expansion type refrigerator (freezing capacity 2 tons)). The fish were brought back to Palau about 40 days after they were taken and the processing department then packed the yellowfin in oil.

After the fish were butchered the raw flesh was examined. It was dark brown in color and at first glance did not look very good. After it was steamed (preparation 40 minutes, 2½ hours at 2 pounds) the flesh was not split or broken, but the part next to the skin had a deep yellow gloss, looking as if it had been cooked in oil. In general these fish seemed to have a higher fat content than those from Palau waters. After cooling for 18 hours the fish was examined again at which time it showed a dark red-brown color and had a rather high water content but was firm.

Some of this material showed "honeycombing" around lesions caused by hooks, but otherwise very little "honeycombing" was seen.

Results

On the whole this experimental fishing showed a very poor fishing situation, perhaps because the wrong time was chosen, or the gear was not suited to the fishing grounds, or perhaps for reasons having to do with the schools and various meteorological and oceanographic factors.

It is, of course, extremely difficult to determine the value of the tuna fishing grounds of this area on the basis of such a short investigation, however, a consideration of only the results of these experiments gives a very unfavorable picture and contradicts the commonly heard saying that "around Woleai the water is full of tuna and skipjack."

Naturally it is not a question of evaluating the fishing grounds of this area summarily on the basis of this one investigation. This study has obtained only a part of the reference data on the fishing grounds of Woleai and Lamotrek. Later continuations of this investigation will clarify the total aspect of the fishing grounds of this area by accumulating data for the study of such basic subjects as the relationship between meteorological and oceanographic factors and the fishing situation, the distribution of the schools, and the courses of migrations, while at the same time testing the suitability of fishing gear and methods.

The following is a summary of the results of oceanographical and fishery observations made during the period of this study:

1. Schools are sparse. Tuna are distributed west of Woleai, spearfish to the east.

2. The catch ratio increases farther away from shore.

3. Water densities, except on one or two grounds, decrease as the depth increases.

4. Hydrogen ion concentration generally decreases from the higher to the lower levels.

5. Water color is No. 3 both east and west of the Ifalik Islands (where it is No. 2).

6. Water clarity is generally greater to the west of Woleai and less to the east.

Table of Experimental Tuna Fishing Data from Woleai Waters April 1936

Date		4-10	4-11	4-12	4-13	4-14	4-15	4-16
Symbol		A	B	C	D	E	F	G
Latitude		7°23'N	7°13'N	7°22'N	7°14'N	7°19'N	7°33'N	7°47'N
Longitude		143°9'E	143°15'15"E	143°36'E	143°49'E	144°0'E	143°45'E	143°56'E
Time of Observation		1624	0635	1700	1200	1216	1622	1200
Weather, Amt. of Clouds		B 3	B 3	BC 6	BC 6	0 9	R 10	B 3
Wind direction, force		E 3	NE 3	NE 2	E 2	NE 3	NE 2	ENE 4
Atmos. pressure		761.7	761.4	761.4	761.4	761.5	761.5	761.7
Atmos. temperature		28.5	27.0	27.0	28.0	28.0	27.0	28.0
Water temperature	0 m	28.8	28.5	28.8	28.8	28.5	28.3	28.5
	25 m	28.8	28.5	28.8	28.8	28.5		
	50 m	28.5	28.5	28.7	28.7	28.4		
	100 m	28.2	28.3	27.1	27.4	28.4		
	200 m	16.1	15.6	15.2	14.9	28.1		
	300 m	10.5	10.3	10.6	10.5	27.5		
Specific gravity	0 m	25.72	25.72	25.77	25.72	25.70	25.58	25.61
	25 m	25.70	25.70	25.64	25.68	25.58		
	50 m	25.67	25.70	25.64	25.67	25.50		
	100 m	25.67	25.72	25.67	25.67	25.52		
	200 m	25.61	25.64	25.61	25.65	25.52		
	300 m	25.61	25.58	25.58	25.61	25.47		
pH	0 m			8.5	8.4	8.4		
	25 m			8.5	8.4	8.4		
	50 m			8.4	8.4	8.4		
	100 m			8.4	8.4	8.4		
	200 m			8.3	8.2	8.4		
	300 m			8.1	8.1	8.4		
Water color		3	3	3	3	3	3	3
Transparency		34m	35m	33m	35m	33m		
Direction of current		W	S	S	N	N	S	N
Velocity of current		1/2	3/4	1/2	1/2	1/4	1/4	1/2
Time gear set		1530-1624	0440-0520	1600-1655	1430-5.26[?]	0500-0549	1530-1622	0415-0525
Time gear taken up		1930-2230	0830-1045	2030-2230	1400-1645	2300-1545[?]	1920-2245	1310-1525
Number of hooks		240	222	234	216	216	240	240
Bait, species		salted iwashi	=	=	=	=	=	=
Bait, number		292	258	268	285	265	290	285
Yellowfin taken		2		1		1		
Big-eyed taken		1						
Spearfish taken								1
Skipjack taken								cybiid 1
Sharks, etc. taken							shark 4	
Tuna catch ratio (fish per 100 hooks)		1.25		0.43		0.46		

Date		4-17	4-21	4-22	4-23	4-24	4-25
Symbol		H	I	J	K	L	M
Latitude		7°36'N	7°21'N	7°34'N	7°36'N	7°33'N	7°19'N
Longitude		143°56'E	144°23'E	144°26'E	144°37'E	145°51'N	146°26'E
Time of Observation		1200	1325	1230	0757	1235	0839
Weather, Amt. of Clouds		TQ 10	R 10	BC 5	BC 4	BC 6	BC 4
Wind direction, force		NE 4	NE 2	N 3	E 3	ENE 3	ENE 2
Atmos. pressure		761.7	761.7	761.8	761.4	759.9	757.4
Atmos. temperature		28.5	26.5	28.5	28.0	29.0	29.0
Water temperature	0 m	28.5	28.9	28.8	28.8	29.0	29.0
	25 m	28.5	28.9	28.8	28.8	29.0	29.0
	50 m	28.5	28.8	28.3	28.8	29.0	29.0
	100 m	27.8	27.9	28.3	27.9	28.5	28.8
	200 m	14.5	14.2	15.5	14.6	16.7	15.2
	300 m	10.8	10.8	10.8	11.1	10.9	7.9
Specific gravity	0 m	25.80	25.72	25.44	25.72	25.72	25.76
	25 m	25.70	25.65	25.44	25.72	25.72	
	50 m	25.70	25.64	25.50	25.65	25.70	25.70
	100 m	25.61	25.55	25.58	25.64	25.70	25.65
	200 m	25.58	25.55	25.44	25.58	25.61	25.64
	300 m	25.58	25.52	25.44	25.55	25.58	25.65
p H	0 m	8.4	8.3	8.4			
	25 m	8.4	8.3	8.4			
	50 m	8.4	8.4	8.4			
	100 m	8.4	8.4	8.4			
	200 m	8.2	8.1	8.2			
	300 m	8.1	8.1	8.1			
Water color		3	3	2	2	2	3
Transparency		29m	31m	29m	28m	27m	28m
Direction of current		NNW		NW	SW	S	SW/W
Velocity of current				3/4	1/2	3/4	
Time gear set		0445-0535	1225-1313	0500-0545	0545-0645	0455-0550	0437-0530
Time gear taken up		0910-1155	1800-2050	1300-1600	1310-1550	1310-1545	2125-1215
Number of hooks		240	240	240	240	240	240
Bait, species		salted iwashi	=	=	=	=	=
Bait, number		282	298	282	295	265	283
Yellowfin taken							
Big-eyed taken							
Spearfish taken					2	1	2
Skipjack taken						1	
Sharks, etc. taken					shark 2	shark 3	cybiid 1 shark 1
Tuna catch ratio (fish per 100 hooks)					0.83	0.41	0.83

Oceanography

The basic oceanographic investigations consisted of observations made three times each month. They revealed the following conditions in these waters. For the sake of convenience in describing this area it is divided into the lagoon waters and the open sea with the barrier reef as the boundary.

The outer face of the reef drops off steeply at some places and more gradually at others, but for the most part it is an almost vertical wall where the surf breaks at all seasons and where there are no places which offer important possibilities for fishing.

A current of ½ to 1 knot strikes the eastern point of the island at the reef off Metalanim, and divides into two branches. One branch flows westward and then follows the reef north. Near the Ponape Harbor channel it develops a southerly current (counter-current), but it continues northward and joins the northern current off the northern tip of the island after which it continues westward.

Away from the reef face the water is several hundred meters deep and the bottom cannot be seen. Consequently nothing is known of the weeds, fish, or shellfish which occur there. Visibility in the water extends from 12 to 15 fathoms. The northeast trades blow continuously from November to May and during this period the sea is rough everywhere to the northeast of the island, the only calm areas being in the lee of the island within 3 or 4 miles of the southwestern shores. From June to October the winds are from the southwest and the sea is calm all around the island.

The barrier reef may be divided into a northern and a southern part by a line drawn from east to west through the center of the island. On the south coast the reef is very close to the shore, but the northern part is rather extensive in places. Channels such as the Tauak, Barukiru, Jokaj, Ponape, Mant, and Aru passages connect the lagoon and the open sea. The depth of the lagoon is irregular, but shoal patches under 30 fathoms are found only rarely near the mouths of rivers and the greater part of the lagoon has depths of over 40 fathoms.

The bottom is mud with a good deal of reef rock. There are no sand beaches on the main island, white sand being seen only around the small islands within the lagoon. The lagoon is calm even during the trade wind season, but it gets rather rough in the vicinity of Jokaj and Mant.

The currents vary with the topography and the tide, however, near all the entrances the current runs into the lagoon with the rising tide and out to sea as the tide falls. These tidal currents are rather swift.

There is some danger due to the turbid condition of the water in the lagoon which makes it difficult to see shoal patches.

Meteorology

This island is within the tropics and consequently has a summer climate all year round with only slight variations in temperature and atmospheric pressure. Rainfall is abundant, and as the wind blows from the sea at all seasons the climate is generally equable. The major seasonal difference is that between the trade wind season from December to April and the season of calms from May to November.

Variations in the temperature depend on the rainfall and the wind, and are generally slight throughout the year. The annual average is 26.0°C, with a maximum of 33.0°C (September) and a minumum of 21.0°C (January) giving a range of 12°. The variation within any one month does not exceed six or seven degrees. Generally the trade wind season is cool, while during the season of calms the direct rays of the sun are extremely strong and one feels hot both in and out of doors. However, there are many showers during this season, and although it becomes very hot during the day, between midnight and morning the temperature drops markedly giving rise to a wide variation between day and night temperatures.

Average wind velocity throughout the year is from 2 to 4 meters. The wind is strongest from January to March, falls off after April and May, and is at its lowest in August, September, and October. Beginning in November the wind gradually increases in strength. Between the calm season and the trade wind season there are occasionally sudden storms of short duration.

The winds are almost entirely from the northeast or east. During the calm season they are intermittent and tend toward the south, producing southeast winds. The yearly variation extends from northeast to southwest, but north and west winds are extremely rare.

Annual average humidity is 83%. It is lowest during the northeast trades from January to March, and highest in July, August, and September during the calm season.

Maximum sunlight is found in August and September.

Since the peak of the island rises up out of the ocean to an altitude of 770 meters, the tops of the mountains are always covered by clouds and rainfall is abundant. More rain falls during April, May, June, October, November, and December, and less during January, February, March, July, August, and September, showing two changes within the year. The months of greatest precipitation are April with 699 mm and December with 696 mm. March has the least with 278 mm. There is almost no distinction of wet and dry seasons on this island, the term "dry season" being applied only to the rainless periods of less than twenty days which occur several times during the year. At other times there are so many showers that not a day passes without some rainfall.

Location and Description of Fishing Grounds

For the sake of convenience the coast of the island is divided into

sectors, with each sector further divided by the reef into an inner and an outer part.

Sector 1

Within lines drawn from the center of the island through the Ponape Harbor channel and Mant Passage.

Inner Section

A broad lagoon including the three islands of Param, Langar, and Japutik with their adjoining reefs, it contains a considerable area. The part near the barrier reef is suitable as a fishing ground for sea-cucumbers and many reef fishes also occur there.

Outer Section

Includes the northern tip of the island and is a good fishing ground for skipjack and tuna. In the trade wind season the natives of Mokil I. troll from canoes for skipjack, tuna, and cybiids between the north point and Ponape channel. In the calm season the natives of Greenwich I. fish with pole and line for tuna at the entrance to the channel. Schools of skipjack and tuna often come into the adjacent waters, being especially abundant at dawn, at dusk, and in rainy weather during the calm season.

Sector 2

From Mant Passage to Aru Passage

Inner Section

This broad lagoon is a continuation of the first sector, and includes the two islands of Mant and Tapak. Fringing reefs are developed in the vicinity and there are many isolated reefs. There is a winding channel by which one can traverse the sector. In the deep places fronting on the channel there is much black lip pearl shell.

Outer Section

Scattered schools of tuna and skipjack are seen along the coast from the north tip of the island. Since this sector is on the windward side during the trade wind season, it is rough and the waters near the barrier reef are generally unsuitable as fishing grounds.

Sector 3

From Aru I. to Metalanim Harbor

Inner Section

From Aru to off Oa there is a channel inside the reef, but farther south the fringing reef extends to the barrier reef and the whole lagoon is shallow. The bottom is sand with scattered rocks. Even at high tide only small boats can make their way through the areas. This is a good fishing ground for beche de mer.

Outer Section

Like Sector 2 this area is rough during the trade wind season and operating is difficult. The outer face of the reef is steep and only an occasional cybiid can be picked up by trolling there. There are skipjack and tuna schools off the entrance to Metalanim harbor and it is thought to be a good fishing ground.

Sector 4

Metalanim Harbor to Mutok Harbor

Inner Section

Except at Lot Harbor, the outer fringing reef connects with the barrier reef and does not afford passage even for small boats. The ruins of the famous Nammatal castle are found within this area. It is a good fishing ground for sea-cucumbers and 鮹 [species unidentifiable].

Outer Section

The seaward shores of Nar I. and Narlap I. slope off fairly gradually and are a good fishing ground for carangids. There is always a strong swell even in the calm season and the sea is rough at all seasons of the year. Few skipjack and tuna schools come into this area.

Sector 5

Mutok Harbor to Ronkiti Harbor

Inner Section

The fringing reef connects with the barrier reef and there are small boat channels only at Kapitau Puloj, Kapitau Natik, and Kapitau Tol. There is no boat channel parallel to the reef inside the lagoon. All of the channels through the reef can be used as anchorages.

Outer Section

The reef face has some gently sloping places but most of it is steep, and like Sector 4 the sea is rough all year round.

Sector 6

Ronkiti Harbor to Tauak Passage

Inner Section

This section has a rather extensive area and the lagoon is deep in places. Small boats can pass from Tauak to Toletik I., but the water is over 30 fathoms deep and there are few suitable anchorages. Scattered isolated reefs make navigation extremely hazardous. This is a good fishing ground for hawksbill turtles, green turtles, and sponges.

Outer Section

During the trade wind season this section is in the lee of the island and the area between Tauak and Palang passages is especially calm. There are many dog-toothed tuna [Gymnosarda nuda] in this vicinity.

Sector 7

From Tauak Passage to Palikir Passage

Inner Section

The lagoon is extensive and is freely navigable by large ships.

Outer Section

The reef slopes off rather gently in the vicinity of Palikir Passage, and the waters off shore are thought to be a favorable fishing ground.

Sector 8

From Palikir Passage to Ponape Harbor

Inner Section

A broad expanse of lagoon including Jokaj I. The central portion is deep and is freely navigable by large vessels.

Outer Section

Skipjack and tuna are seen in this area and it appears to be a good fishing ground.

To summarize, the fringing reef around this island has almost the same area as the island itself. The barrier reef extends out to the northward while on the south it lies close in to the island. For this reason when a line is drawn from east to west through the center of the island dividing it into northern and southern sections, we find that the lagoon in the north has an extensive water area, while in the south the fringing reef and the barrier reef almost run together, there is no deep water, and navigation is difficult.

The water within the reef is generally not clear and there are scattered shoals which make navigation dangerous. Furthermore the deeper places within the reef are too deep to serve as anchorages.

Bait Fish Investigation

The main skipjack bait species are juvenile akamuro [may be Decapterus russelli] and shimamuro [Decapterus spp.]. Some sardine-like [iwashi] species also occur, but they are hard to catch. The young of the various species of Decapterus occur abundantly in the shallows within the lagoon and are taken with driving-in nets. The sardine-like species do not inhabit the clear waters among the reefs, but live among the mangroves where the water is calm and the bottom is mud or sand. Although they can be taken with throw nets they are generally difficult to catch and consequently are not used as live bait. When salted down they are very good bait for tuna longlines.

Skipjack Fishery Investigation

As one of the fisheries most important in the development of the marine resources of this island, the skipjack fishery requires a most thorough investigation. Since the success or failure of this fishery depends on the supply of bait fish, our investigations were mainly concerned with the baiting grounds. The results are given in the paragraph on the bait fish investigation. Water temperatures and salinities in the vicinity of the island are suitable for skipjack, and the fish may be seen and easily taken in the coastal waters at all seasons. Species of Decapterus occur abundantly near the islands of U, Tapak, and Mant, and they are not hard to catch. The sardine-like fishes live in the mangrove swamps and consequently some thought must be given to devising a means of capturing them.

Trolling Investigation

Purpose

This investigation was made in order to find the fishing grounds in the waters adjacent to this island and to ascertain the species and abundance of fish occurring there.

Method

Ordinary artificial lures were trolled on two lines 50 or 60 fathoms long from each side of the stern of a boat making 6 or 7 knots.

Fishing Gear

The gear was made up of line, cotton-served hemp [sekiyama], wire, and hooks, and was kept in line baskets. The hooks were made of tinned iron and were 4.8 inches long and weighed 1.6 ounces. Both round and angular types were used. The lures were made of scraped cow-horn. A hole was pierced through the center and a wire was passed through so that the

horn could move freely on it. Some white feathers and red bristles were bound on one end and the lure was wrapped in balloonfish skin.

Catch

Within the lagoon carangids, cybiids, rarely frigate-mackerel [Auxis sp.], and miscellaneous reef fish were taken, but few catches were made. Outside the lagoon along the face of the barrier reef tuna, dog-toothed tuna [Gymnosarda nuda], carangids, skipjack, cybiids, and reef fish were taken. Cybiids predominated in the catch. More carangids were taken in comparatively shallow places, and more tunas in deeper water.

This fishery is greatly affected by weather and tide. Fishing is generally good at dawn, at dusk, in cloudy and rainy weather, and before and after storms, but it is not good in clear weather or when the sea is very calm. Fishing is better when the tide is rising than at low tide.

Tuna Fishery Investigation

In the past the natives of this island have not engaged in fishing outside of the barrier reef. Tuna for local consumption has been supplied all year round by the natives of Mokil I., who troll for tuna from sailing canoes during the trade wind season, and by the natives of Greenwich I., who take them with pole and line during the calm season. [TN. The Mokil Is. are about 90 miles from Ponape. Greenwich or Kapingamarangi is about 400 miles to the southwest of Ponape.]

Purpose

This investigation was made in order to supply the data necessary for establishing a tuna fishery.

Meth..

Experimental fishing with longlines was done on the grounds which had been previously discovered by trolling.

Fishing Gear

Bōshū-type longlines, six hooks, twenty baskets
Research vessel - No. 2 Hakuō Maru

Fishing Grounds

The investigation was of short duration and it would be difficult to pass a definitive judgment as to whether these should be called good fishing grounds with respect to the concentration and abundance of fish. The whole circumference of the island appears to be about the same, but the waters off Sectors 1, 3, and 4 seem to be particularly good fishing grounds.

Bait

The only suitable bait fish at this island are flyingfish and iwashi [sardine-like fishes]. The flyingfish are taken in large numbers outside of the lagoon near the barrier reef, while the iwashi live in the mangrove areas and are easily taken with throw nets.

Catch

The catch is of the same general composition all around the island. Yellowfin are the most numerous element with comparatively small ones being taken in the upper layers and larger ones at greater depths. For this reason more fish were taken on the long branch lines.

In this fishery few fish are taken exept at dawn and around sunset or in rainy weather. Near the outside of the barrier reef there are many dog-toothed tuna, but none were taken on the longlines. There are small tuna mixed in with the surfaced skipjack schools off shore (ascertained by trolling).

This experimental fishing was done in conjunction with a shark fishing investigation. Sharks were taken at every set and there was also some damage to the tuna from shark-bite.

Table of Fishing Data

This covers the fishing done during 1928.

Shark Fishery Investigation

The natives do not regard the shark as a harmful fish and consequently hardly any are taken. However, in the period of German rule the natives were taught how to prepare shark fins, and it is said that at the time of our occupation of the islands there was quite a quantity of prepared fins in possession of the Jaluit Company. These are thought to have been taken by the natives of the outlying islands rather than by the people of Ponape itself. In the native language the sharks are called pako. They are of the kind called hiragashira [Scoliodon sp.] by the Japanese and occur abundantly along the shores. During trolling and longline operations they steal the catch and are sometimes caught themselves.

Fishing Gear

No specially designed gear was used in these tests which were run in conjunction with the tuna longline fishing experiments. The gear and methods are therefore the same as those used in the tuna investigation.

Flyingfish Fishery Investigation

Purpose

This experiment was made principally to supply bait for longline

Table of Tuna Longline Fishing 1928

Date	Weather Wind	Fishing Ground	Fishing Time	Water Temp.	Current	Bait	Catch		Weight	Notes
							Species	Number		
1-12	C NE 5	Sector 6	[illegible] A.M. 1:00 P.M.	28.5	NNW	iwashi	none			Rough;operati difficult; ca ed off fishin
5-11	R NE 2	" 1	10:05 A.M. 4:10 P.M.	29.0	N	flyingfish	shark	1	15,000	
5-17	B NE 2	" 3	6:35 A.M. 10:35 A.M.	29.5	SE	flyingfish iwashi	tuna shark	1 2	4,000 10,000	
5-18	B SE 1	" "	8:50 A.M. 10:20	29.5	SE	iwashi	tuna	1	2,000	
9-11	C SW 3	" 1	7:10 11:50	29.6	N	"	none			
9-13	B NE 1	" 3	6:15 9:00	29.3	SE	"	tuna shark	1 1	1,000 5,000	
9-19	C N 1	" 1	1:35 2:00	29.3	N	"	none			
9-20	B SW 1	" 1	7:00 A.M. 1:00 P.M.	29.5	W	"	tuna	1	3,000	
9-26	B SE 1	" 3	7:05 " 1:45 "	29.5	SE	"	none			
9-27	"	" "	6:15 A.M. 11:35	29.5	E	"	"			
9-28	"	" "	4:00 A.M. 9:43	29.8	S	"	tuna	2	4,000	
10-9	B NE 1	" 4	6:00 A.M. 1:50 P.M.	29.8	S	"	"	1	1,000	
10-12	C SW 3	" 7	4:30 A.M. 9:03	29.8	S	"	none			

[TN. The units of weight in the above table are probably momme. 1 momme = .1325 ounce.]

fishing and for trolling, but also to investigate the supply of these fish for consumption as fresh, salted, or dried fish.

Method

The research vessel with 20 bundles of net aboard proceeded to the fishing ground and waited for nightfall. The net was set outside of the lagoon across the current with one end of the net close to the reef and the rest of it stretched straight out to sea. The last three bundles of net were set in a semi-circle. As the net drifted with the current a boat patrolled it from time to time removing the fish which had become caught in it.

Fishing Grounds

These fish can be seen flying over the surface of the sea both inside and outside of the reef at all times of the year. Schools of juvenile fish are particularly abundant around the entrances to channels and at indentations in the coast.

A thorough investigation could not be made because of the danger of night operations on fishing grounds so near to the reef, but it appeared that Sectors 1, 6, and 7 are good grounds. The currents are swift, however, and abnormal currents in and out of the channels occasionally tangle the nets.

Fishing Season

The fish are seen throughout the year, but the seasons of comparative abundance and scarcity have not yet been ascertained. It appears, however, that April and May are the peak of the season. It appears that drift net operations would be difficult or almost impossible during the trade wind season. The fish are taken in large numbers at moonrise and moonset of the new moon (3rd to 7th day) and the full moon (15th to 18th day) of each month, and at other times the catch is small.

Note

These fish are taken in large numbers by the natives of the outlying islands and are an important item in their diet. They go out with torches in canoes at night to fishing grounds near the reef and catch the fish in scoop nets. They sometimes catch several hundred fish in one night.

Reef Fish and Shallow Water Set-line Investigation

Purpose

Tests were made using simple methods to provide data for general reference.

Fishing Gear

The type of set-line used for catching flounders in Tōkyō Bay was

employed.

Fishing Grounds

Locations were chosen near the fringing reef in the vicinity of mangrove woods or where the sea weeds grew comparatively luxuriantly.

Bait

Iwashi cut up in small pieces.

Catch

Local names - aron (carangid), shamoi, ashinmeru (akamasu) [prob. Lutjanus sp.], mangāru, monmei, ikamu, hirakasago [prob. a scorpaenid], mebaru, and fish like the kuchibidai [prob. Lethrinus sp.] predominated.

Progress of the Tests

Three baskets of line with 70 hooks to a basket were employed. The lines were set twice a day before sunrise and before sunset. This type of fishing is affected by the tide and the best results are obtained when the line is set while the tide is rising. The catch per set ranged on the average from five or six to ten fish. There was some damage to the catch by sharks, and the gear was damaged by large fish such as carangids and akamasu which broke off the hooks and tangled the lines.

Results

This type of fishing is all right for recreation or to supply fish for one's own table, but it is of small value as a commercial fishery.

Sponge Culture Investigation

Sponges grow profusely everywhere around the coasts of the island, and the natives commonly use them in place of wash cloths. Even at the present time they have the custom of giving sponges as gifts at the birth of a child. Investigation showed that the sponges were scattered everywhere around the circumference of the island, but they are particularly abundant in Sectors 1 and 2. During the course of the fishing investigations some sponge culturing disks were planted in the shallows north of Japutik, but the work was halted before the results could be seen and so it is unfortunately impossible to report on the experiment in this paper.

It appears, however, that at this island sponges have a great deal of value as a promising resource for future exploitation.

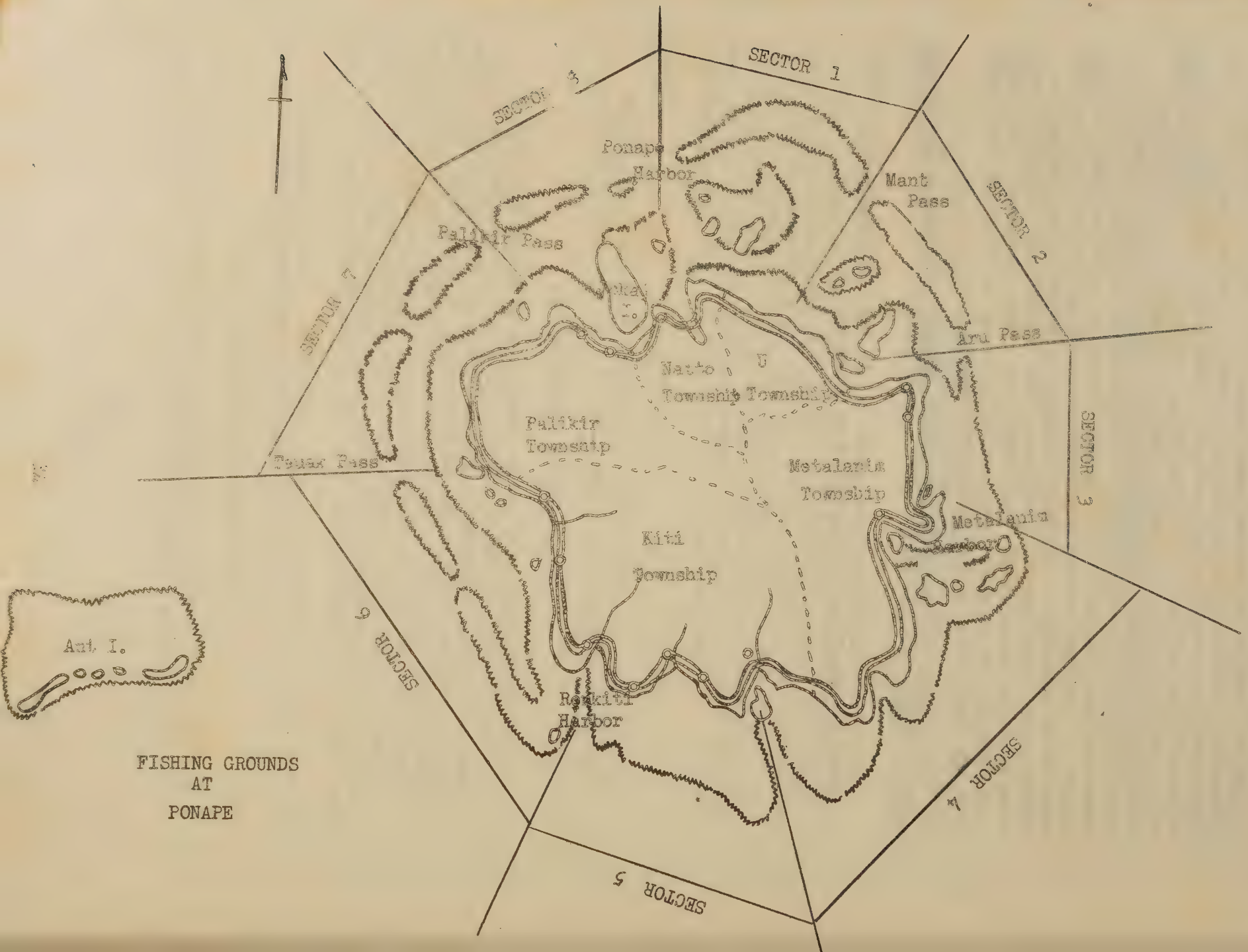
Trochus Transplantation Experiment

In the past trochus shells have never been observed to inhabit the waters of Ponape, and some experiments in transplanting them from Palau have been made.

On October 6 and December 7, 1927, two lots of trochus totaling 27 shells were brought on the freighter Yawata Maru. The animals were fatigued by the voyage and arrived in a state of lowered vitality. Immediately upon receipt they were put in wire baskets and placed on the bottom off the southwest tip of Langar I. A good deal of thought was given to the choice of a planting site. The waters outside of the reef were thought to be suitable for planting, but the rough seas made investigation difficult and consequently we were forced to plant them inside the lagoon at what appeared to be a suitable location at the southwest tip of Langar I. The wire baskets were sunk on the fringing reef in a depth of about three fathoms, and numerous pieces of coral were piled inside the baskets to simulate natural conditions. The baskets were planted in such a way that the animals could feed freely but could not escape. The shells were examined for survival occasionally by diving and each time this was done the coral rocks in the baskets were changed.

The shells died off gradually after planting and in three months they were all dead.

In future transplantations better results will be obtained by planting the shells at the entrances to channels.



FISHING GROUNDS
AT
PONAPE

An Investigation of the Skipjack Fishery in the Waters of Woleai, With Notes on the Bait Situation at Lamotrek and Puluwat Is.

Introduction

Although the skipjack fishery in the islands has recently made remarkable strides forward, in the outlying areas where facilities for transportation and communication are inadequate this fishery is in a state of complete neglect. For this reason it was planned at this time, in order to develop the industry in the outlying islands, to use the Zuihō Maru and the Hakuō Maru to make an investigation which would ascertain the value of the fishing grounds and provide data for reference in the planning of commercial developments. The waters around the Puluwat Is. were the scheduled area of operations, however, there was no suitable bait in that group and the fishing experiments could not be carried out. Consequently the base of operations was shifted to Woleai, where an investigation was begun July 7 and concluded July 22.

Since a certain amount of time was taken up by the operations at Puluwat, making the period of the investigation brief, and because the technician in charge was not aboard, it was not possible to come to any definite conclusions about the value of the fishing grounds. However, the following is a record of the progress of this investigation.

Particulars

Research vessels Zuihō Maru (183.54 gross tons, Mitsubishi Pikkādo 360 HP airless injection Diesel engine) Hakuō Maru (10 gross tons, Niigata 25 HP semi-Diesel)

Area of investigation seas adjacent to Woleai Is.

Period of investigation July 7 to 22

Personnel Assistant technician incharge Zuihō Maru (Captain and 21 men) Hakuō Maru (11 men)

Fishing gear used skipjack pole-fishing gear

Bait used Aoesa (Barengnlaris Schrarnmi (Bleeker) / probably Harengula schrammi / and akaesa (young tenjikudai / Apogon sp. /) taken with a stick-held dipnet in the bays at Woleai were used.

Method of investigation Experimental fishing was done using single-pole gear. Oceanographic observations were made on the fishing grounds, and the distribution of schools, the suitability of fishing gear and methods, and the relationship between sea conditions and fishing conditions were studied. Marked fish were also released.

Outline of the progress of the investigation

The Zuihō Maru with the Hakuō Maru in tow departed Palau June 7 to make a survey of the skipjack fishery of the Puluwat Islands, however,

owing to the difficulty of carrying out experimental fishing in that area, it became necessary to shift the base of operations to Woleai I. On June 21 the vessels called at Truk to replenish fuel and provisions, leaving that port on the 28th. Making oceanographic observations en route, the vessels stopped at Puluwat and at Lamotrek (for a bait investigation). They arrived at Woleai on July 7 and the first fishing trial was made on the 9th off Falalis I. In all 7 trials were made.

The fishing grounds were chiefly about 10 miles off Falalis and Utagal islands; the grounds northeast of Woleai were inactive. Fishing ended on the 16th and on the 22nd the vessels returned to Palau.

An outline of the results of this investigation is as follows:

Days of operation 7	Number of schools sighted 13
Times fished 8	Number of catches made 7
Times fish did not bite 1	Number of fish taken skipjack 785
	tuna 209*

Marked fish released 100 (ta 100 - ta 199, see table)
Body measurements (average of 100 fish) weight 6½ pounds
length 51.7 cm. depth 15.0 cm. breadth 12.3 cm.

Fishing Conditions

Quite a few schools were sighted, perhaps because the period of this investigation may have coincided with the migration of the schools into these waters. Skipjack and tuna schools were also seen to come into the channel and bay [lagoon?] between Falalis and Utagal islands to feed. As a result of a total of 7 trials, fish were taken 7 times [sic]. The number of hooks fished was 86 and the number of fish taken was 785 skipjack and 209 tuna. Tagging and releasing fish diminished the catch by about 23 per cent, it is thought.

Fishing grounds were chiefly to the south and west of the islands and from 5 to 12.3 miles off shore, although some were sighted to the north and east and schools were seen to come in to the vicinity of the outer reef in search of food. The schools were associated with birds and with drifting logs, and were pretty dense. Many schools were mixed with tuna. The average weight of the fish was 6½ pounds. (see accompanying table of fishing experiments)

Sea Conditions

Oceanographic observations were made 7 times on the various fishing stations. Temperature, density, and salinity were measured at the surface and at depths of 25, 50, 100, 150, and 200 meters, with the following results. (for positions of the fishing stations see the accompanying table of fishing experiments)

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*[The "tuna" referred to were probably small yellowfin.]

Table of Sea Water Temperatures on the Various Grounds
(degrees C.)

Depth / Station	Surface	25 m	50 m	100 m	150 m	200 m
A	29.7	29.4	29.4	26.5	16.6	13.3
B	29.5	29.5	29.3	25.3	18.8	13.4
C	29.6	29.4	28.8	24.0	19.8	13.7
D	29.5	29.3	29.3	26.6	19.7	15.4
E	29.8	29.4	28.8	26.4	18.7	13.7
F	29.5	29.4	29.0	26.2	20.7	16.3

Maximum, Minimum, and Average Temperatures at Each Level
(degrees C.)

Depth	Maximum	Minimum	Average	Range
Surface	29.8	29.5	29.65	
25 m	29.5	29.3	29.4	0.25
50	29.4	28.8	29.1	0.3
100	26.6	24.0	25.3	3.8
150	20.7	16.6	18.65	6.65
200	16.3	13.3	14.8	3.85

Specific Gravities at the Various Stations

Depth / Station	Surface	25 m	50 m	100 m	150 m	200 m
A	25.29	25.40	25.56	25.96	25.92	25.74
B	25.41	25.41	25.44	25.98	25.87	25.74
C	25.43	25.43	25.71	25.99	25.79	25.73
D	25.16	25.16	25.31	25.96	25.96	25.72
E	25.19	25.52	25.64	25.96	25.86	25.70
F	25.31	25.34	25.58	25.86	25.92	25.74

Salinities at the Various Stations

Depth / Station	Surface	25 m	50 m	100 m	150 m	200 m
A	34.09	34.23	34.45	34.96	34.90	34.67
B	34.25	34.25	34.29	34.97	34.85	34.69
C	34.27	34.27	34.63	34.99	34.72	34.67
D	33.93	33.97	34.11	34.96	34.96	34.65
E	33.96	34.38	34.54	34.96	34.83	34.61
F	34.11	34.14	34.47	34.83	34.90	34.69

Temperatures

During the period of the investigation the temperatures at the various levels showed roughly similar readings.

Surface 29.5 to 29.8 degrees; 25 meters 29.3 to 29.5 degrees; 50 meters 28.8 to 29.4 degrees; and 100 meters 24.0 to 26.6 degrees. The temperature dropped sharply at the 150-meter level, with a range of 5.9 to 7.4 degrees between 100 and 150 meters. The 200-meter level showed a further drop, with a range of difference of 10.3 to 10.7 degrees from the 100-meter level. The following tables give the temperatures at the various stations.

Water Color and Clarity

Water color was determined by using Forel's standard fluid. At all seven stations in Woleai waters the color was No.1, except for Station A where it was No.2.

Clarity was measured by lowering a white plate 1 foot in diameter into the sea. Visibilities recorded at the various stations were closely similar, with a maximum of 33 meters. It is thought that the more notable variations in visibility were due to variations in the brightness of the sunlight.

Disposition of the Catch

After the fish were caught they were dry frozen in the Zuihō Maru's freezer (2 tons freezing capacity) and held in that vessel's cold storage.

Conclusions

The fishing situation turned out to be rather good, perhaps because this investigation may have coincided with the time of the schools' migration into these waters. It is, however, extremely doubtful whether the schools come into these waters at all times of the year. At the time of the last tuna fishing investigation at Woleai the fishing situation was very unfavorable, and skipjack schools, too, were rarely sighted. It is therefore thought that the skipjack schools found in these waters are of a migratory character, however, the period of this investigation was too short to make it possible to determine whether they migrate under the influence of some oceanographic or other factors or whether they come at regular periods, and it is impossible to assess the value of the fishing grounds solely on the basis of these experiments. It is hoped that with the data from this investigation and with the accumulation of more data in successive investigations we will be able to evaluate these fishing grounds and clarify the total aspect of the fishery so as to provide material for reference in planning commercial operations.

Progress Report on Bait Fish Investigations at Lamotrek I.

A survey of the bait fish essential to the skipjack fishery was carried on in this area with the methods and results outlined below.

Method of Investigation

Eight fishermen who were excellent divers were assigned to diving at various points around the atoll reef in order to discover bait fish, and at the same time a study was made of the distribution, density, and identification of the bait fishes in order to determine the feasibility of utilizing them.

Outline of the Progress of the Survey

Diving operations employing eight divers disclosed that around Lamotrek Island, that is, on the eastern part of the reef, bait is extremely scarce, while on the northern, southern, and western portions there is a fair amount. Because of the short time devoted to the survey, no experiments on taking bait were made and the amount which might be taken is not clearly known, however, it is thought that it would be sufficient for the operation of a 15-20 ton fishing vessel.

The fish seen in the southern portion of the reef were aoesa [probably Harengula schrammi] (however the number of these diminished closer to Lamotrek I.). To the north (north of the pass) and west schools of aoesa and akaesa [Apogon sp.] suitable for skipjack bait were seen everywhere. The scarcity of bait around Lamotrek and the abundance of it around Pugue and Falaite islands is thought to be due to the fact that the former being farther from the pass has a poorer circulation of currents and consequently offers a less favorable habitat for bait fish than the latter, which are near the pass and have a constant circulation of water. Other than the aoesa and akaesa no bait fish suitable for skipjack fishing was discovered in the lagoon of this atoll. The survey was made from July ? to 6, and the vessels departed Lamotrek on the evening of the 6th.

Survey of the Skipjack Fishery at the Puluwat Islands

Introduction

Since the skipjack fishing grounds in the waters around the Puluwat Is. had not yet been fully surveyed, it was intended at this time to carry on fishing experiments based on that island in order to evaluate the fishing grounds and thereby provide data for reference in establishing a commercial fishery. However, the results of an investigation of the bait fish, which are the basis of this fishery, disclosed no suitable supply of bait in this group, the survey could not therefore be carried out, and it became necessary to shift the base of operations elsewhere. The presence or absence of bait at these islands is not, of course, to be decided solely on the basis of the present study.

Particulars of the Investigation

Research vessel Hakuō Maru
Personnel 3 Assistant Technicians and the crew of the Hakuō Maru
Method of investigation The best divers among the crew of the Hakuō Maru explored various localities around the reef to discover bait. At night a light was used and the bait fish which assembled around it were observed.

Outline of Progress

For 5 days from June 16 to 20 at Puluwat and Alet islands several fishermen dived and looked for bait in the bay [lagoon?]. No suitable supply of bait was discovered, only an extremely small quantity of ojisan and himeji [goatfish] being seen, with no other prospect of bait for carrying out our experimental fishing. A 3 hour trial with the light at night brought no useful bait, only a few ojisan being collected.

Although we tried in this way to find bait fish both in the daytime and at night, we were unable to discover any suitable concentration of bait for skipjack fishing in this group of islands.

Conclusions

Results of this bait fish survey failed to disclose a supply of bait for a skipjack fishery in the lagoon at this atoll, perhaps because the investigation may have been made at the wrong season. It is, of course, not possible to decide whether there is or is not bait solely on the basis of this investigation, but it is thought that it will be difficult to get suitable bait. Furthermore, the lagoon is shallow and it would be difficult to operate a stick-held dipnet in it.

It was thus impossible to carry on experimental fishing for skipjack because of the scarcity of bait, and the Puluwat Islands skipjack survey was unavoidably called off, only the bait fish survey being carried out.

Date			7-9	7-10	7-11	7-13
Station	Symbol		A	B	C	
	Position	Latitude	7°12'N	7°13'40"N	Utagal I.	Falalis I.
		Longitude	143°43.5'E	143°40'30"E	SW 7 miles	SE .5 mile
	Vessels in sight					
Time of observations			0935	0850	0935	1620
Meteorology	Weather, Cloud Cover		B 4	C 9	BC 7	B
	Wind Direction, Force		NE 1	NE 2	NE 1	
	Atmos. Pressure		29.91	29.88		
	Air Temperature		28.7	28.9	28.2	28.5
Oceanography	Sea Temperature	0 m	29.7	29.5	29.6	29.5
		10 m				
		25 m	29.4	29.5	26.4	
		50 m	29.4	29.3	28.8	
		100 m	26.5	25.3	24.0	
		150 m	16.6	18.8	19.8	
		200 m	13.3	13.4	13.7	
	Converted Specific Gravities	0 m	25.29	25.41	25.43	
		10 m				
		25 m	25.40	25.41	25.43	
		50 m	25.56	25.44	25.71	
		100 m	25.96	25.98	25.99	
		150 m	25.92	25.87	25.79	
		200 m	25.74	25.74	25.73	
	Water Color, Clarity		2 40	1 37	1 39	1
	Current Direction, Velocity					
	Plankton Amount	Zoo-				
		Phyto-				
School	Kind		floating log	birds	floating log	floating log
	Size and Density		dense	fairly dense	dense	dense
	Appetite		good	fairly good	good	no good
Gear	Time of Operation		0830-0930	0830-0845	0832-0928	1600-1610
	Number of Hooks		14	13	13	8
Bait	Species		aoesa*	same	same	same
	Quantity		10 scoops	7 scoops	9 scoops	8 scoops
	Value					
Catch	Skipjack	Large		79		
		Medium	163	[illegible]	158	44
		Small				
	Tuna		67	19	90	10
Notes			Caught bait at 5:30 A.M. then headed for fishing grounds. Sea flat calm. Returned to Woleai at 11:30 A.M. Tagged fish numbered ta 100 to ta 129.	After taking bait, headed for fishing grounds at 5:00 A.M. Dodging showers all day. Sea flat calm.	Headed for fishing grounds at 5:30 A.M. Returned at 11:30 A.M. Zuihō Maru's refrigerator not functioning properly. Tagged fish ta 130 to ta 149.	Headed for fishing grounds at 4:30 A.M. Fished late so anchored between Falalis and Utagal. Tagged ta 150 to 164.

*/ Probably Harengula schrammi /

Date			7-14	7-15	7-16
Station	Symbol		D	E	F
	Position	Latitude	Utagal I.	Utagal I.	Utagal I.
		Longitude	SW 8 miles	W 6 miles	W 5 miles
	Vessels in sight				
Time of observations			1440	1150	1440
Meteorology	Weather, Cloud Cover		C 9	BC 6	C 8
	Wind Direction, Force			NE 1	SE 2
	Atmos. Pressure				
	Air Temperature		28.0	28.5	28.2
Oceanography	Sea Temperature	0 m	29.5	29.8	29.5
		10 m			
		25 m	29.3	29.4	29.4
		50 m	29.3	28.8	29.0
		100 m	26.6	26.4	26.2
		150 m	19.7	18.7	20.7
		200 m	15.4	13.7	16.3
	Converted Specific Gravities	0 m	25.16	25.19	25.31
		10 m			
		25 m	25.16	25.52	25.34
		50 m	25.31	25.64	25.58
		100 m	25.96	25.96	25.86
		150 m	25.96	25.86	25.92
		200 m	25.72	25.70	25.74
	Water Color, Clarity		1 33	1 46	1 33
	Current Direction, Velocity				
	Plankton Amount	Zoo-			
		Phyto-			
School	Kind		birds	birds	birds
	Size and Density		dense	dense	thin
	Appetite		good	good	fairly good
Gear	Time of Operation		1410-1435	1125-1140	1420-1430
	Number of Hooks		8	15	15
Bait	Species		aoesa*	same	same
	Quantity		10 scoops	10 scoops	10 scoops
	Value				
Catch	Skipjack	Large	144	146	81
		Medium			
		Small			
	Tuna		23		
Notes			Headed for fishing grounds at 5:00 A.M. Tagged ta 165 - 199. Saw schools all over near the reef.	Headed for fishing grounds at 4:20 A.M. Sighted schools twice. Felt painfully the slowness of the boat.	Headed for fishing grounds at 4:40 A.M. Sighted schools 3 times. Windy and rough. Returned to Woleai at 6:00 P.M. Survey ended.

*[Probably Harengula schrammi]